

Artificial Intelligence and Soft Computing

Behavioral and Cognitive Modeling
of the Human Brain

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Artificial Intelligence and Soft Computing

Behavioral and Cognitive Modeling of the Human Brain

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PREFACE

The book, to the best of the author's knowledge, is the first text of its kind that presents both the traditional and the modern aspects of 'AI and Soft Computing' in a clear, insightful and highly comprehensive writing style. It provides an in-depth analysis of the mathematical models and algorithms, and demonstrates their applications in real world problems of significant complexity.

1. About the book

The book covers 24 chapters altogether. It starts with the behavioral perspective of the 'human cognition' and covers in detail the tools and techniques required for its intelligent realization on machines. The classical chapters on search, symbolic logic, planning and machine learning have been covered in sufficient details, including the latest research in the subject. The modern aspects of soft computing have been introduced from the first principles and discussed in a semi-informal manner, so that a beginner of the subject is able to grasp it with minimal effort. Besides soft computing, the other leading aspects of current AI research covered in the book include non-monotonic and spatio-temporal reasoning, knowledge acquisition, verification, validation and maintenance issues, realization of cognition on machines and the architecture of AI machines. The book ends with two case studies: one on 'criminal investigation' and the other on 'navigational planning of robots,' where the main emphasis is given on the realization of intelligent systems using the methodologies covered in the book.

The book is unique for its diversity in contents, clarity and precision of presentation and the overall completeness of its chapters. It requires no mathematical prerequisites beyond the high school algebra and elementary differential calculus; however, a mathematical maturity is required to follow the logical concepts presented therein. An elementary background of data structure and a high level programming language like Pascal or C is helpful to understand the book. The book, thus, though meant for two semester courses of computer science, will be equally useful to readers of other engineering disciplines and psychology as well as for its diverse contents, clear presentation and minimum prerequisite requirements.

In order to make the students aware of the applied side of the subject, the book includes a few homework problems, selected from a wide range of topics. The problems supplied, in general, are of three types: i) numerical, ii) reflexive and iii) provocative. The numerical problems test the students'

understanding of the subject. The reflexive type requires a formulation of the problem from its statement before finding its solution. The provocative type includes the well-known problems of modern AI research, the solution to some of which are known, and some are open ended. With adequate hints supplied with the problems, the students will be able to solve most of the numerical and reflexive type problems themselves. The provocative type, however, requires some guidance from the teacher in charge. The last type of problems is included in the text to give the research-oriented readers an idea of the current trend in AI research. Graduate students of AI will also find these problems useful for their dissertation work.

The book includes a large number of computer simulations to illustrate the concepts presented in logic programming, fuzzy Petri nets, imaging and robotics. Most of the simulation programs are coded in C and Pascal, so that students without any background of PROLOG and LISP may understand them easily. These programs will enhance the students' confidence in the subject and enable them to design the simulation programs, assigned in the exercise as homework problems. The professionals will find these simulations interesting as it requires understanding of the end results only, rather than the formal proofs of the theorems presented in the text.

2. Special features

The book includes the following special features.

i) Unified theme of presentation: Most of the existing texts on AI cover a set of chapters of diverse thoughts, without demonstrating their inter-relationship. The readers, therefore, are misled with the belief that AI is merely a collection of intelligent algorithms, which precisely is not correct. The proposed book is developed from the perspective of cognitive science, which provides the readers with the view that the psychological model of cognition can be visualized as a cycle of 5 mental states: sensing, acquisition, perception, planning and action, and there exists a strong interdependence between each two sequential states. The significance of search in the state of perception, reasoning in the state of planning, and learning as an intermediate process between sensing and action thus makes sense. The unified theme of the book, therefore, is to realize the behavioral perspective of cognition on an intelligent machine, so as to enable it act and think like a human being. Readers will enjoy the book especially for its totality with an ultimate aim to build intelligent machines.

ii) Comprehensive coverage of the mathematical models: This probably is the first book that provides a comprehensive coverage of the mathematical

models on AI and Soft Computing. The existing texts on “mathematical modeling in AI” are beyond the scope of undergraduate students. Consequently, while taking courses at graduate level, the students face much difficulty in studying from monographs and journals. The book, however, bridges the potential gap between the textbooks and advanced monographs in the subject by presenting the mathematical models from a layman’s understanding of the problems.

iii) Case studies: This is the only book that demonstrates the realization of the proposed tools and techniques of AI and Soft Computing through case studies. The readers, through these case studies, will understand the significance of the joint usage of the AI and Soft Computing tools and techniques in interesting problems of the real world. Case studies for two distinct problems with special emphasis to their realization have been covered in the book in two separate chapters. The case study I is concerned with a problem of criminal investigation, where the readers will learn to use the soft computing tools in facial image matching, fingerprint classification, speaker identification and incidental description based reasoning. The readers can build up their own systems by adding new fuzzy production rules and facts and deleting the unwanted rules and facts from the system. The book thus will serve the readership from both the academic and the professional world. Electronic and computer hobbyists will find the case study II on mobile robots very exciting. The algorithms of navigational planning (in case study II), though tested with reference to “Nomad Super Scout II robot,” have been presented in generic form, so that the interested readers can code them for other wheel-based mobile robots.

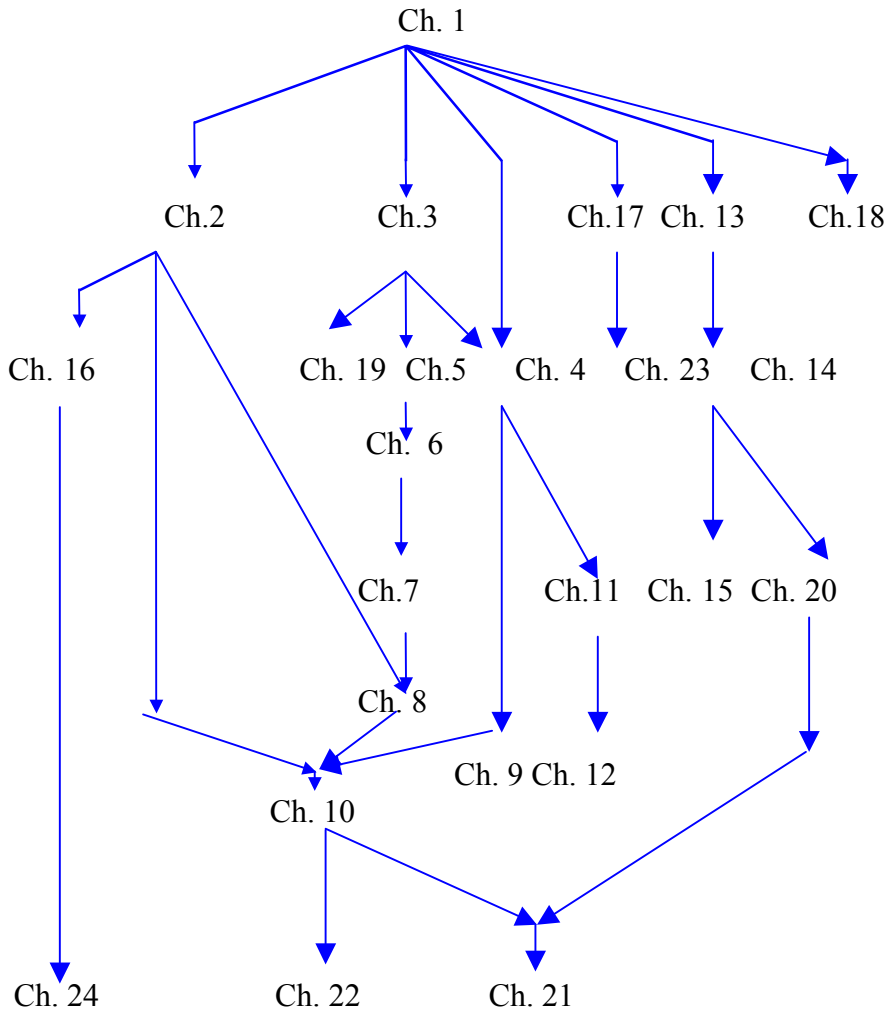
iv) Line Diagrams: The book includes around 190 line diagrams to give the readers a better insight to the subject. Readers will enjoy the book for they directly get a deeper view of the subject through diagrams with a minimal reading of the text.

3. Origin of the book

The book is an outgrowth of the lecture materials prepared by the author for a one semester course on “Artificial Intelligence,” offered to the graduate students in the department of Electronics and Telecommunication Engineering, Jadavpur University, Calcutta. An early version of the text was also used in a summer-school on “AI and Neural Nets,” offered to the faculty members of various engineering colleges for their academic development and training. The training program included theories followed by a laboratory course, where the attendees developed programs in PROLOG, Pascal and C with the help of sample programs/toolkit. The toolkit is included in the book on a CD and the procedure to use it is presented in Appendix A.

4. Structural organization of the book

The structural organization of the book is presented below with a dependency graph of chapters, where $\text{Ch. 9} \rightarrow \text{Ch. 10}$ means that chapter 10 should be read following chapter 9, for example.



ABOUT THE AUTHOR

Amit Konar is a Reader in the Department of Electronics and Telecommunication Engineering, Jadavpur University, Calcutta. He received a Ph.D. (Engineering) degree in Artificial Intelligence from the same university in 1994 and has been teaching the subject of Artificial Intelligence to the graduate students of his department for the last 10 years. Dr. Konar has supervised a number of Ph.D. and M.E. theses on different aspects of machine intelligence, including logic programming, neural networks, cognitive systems, stochastic and fuzzy models of uncertainty, fuzzy algebra, image understanding, architecture of intelligent machines and navigational planning of mobile robots. He has published more than 60 papers in international journals and conferences. He is an invited contributor of a book chapter in an edited book published by Academic Press. Dr. Konar is a recipient of the 1997 Young Scientist Award, offered by the All India Council for Technical Education (AICTE) for his significant contributions in Artificial Intelligence and Soft Computing.

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The author gratefully acknowledges the contributions of many people, who helped him in different ways to complete the book. First and foremost, he wishes to thank his graduate students attending the course entitled “AI and Pattern Recognition” in ETCE department, Jadavpur University during the 1993-1999 sessions. Next, he would like to thank the scholars working for their Ph.D. degree under his supervision. In this regard, the author acknowledges the contribution of Ms. Jaya Sil, a recipient of the Ph.D. degree in 1996, for spending many of her valuable hours on discussion of the Bayesian and Markov models of knowledge representation. The other scholars, to whom the author is greatly indebted for sharing their knowledge in different areas of AI, are Mr. Srikant Patnaik, Mr. Biswajit Paul, Mrs. Bijita Biswas, Ms. Sanjukta Pal, Ms. Alakananda Bhattacharya and Ms. Parbati Saha. The contributions of Mr. Patnaik in chapter 24, Mr. Paul in chapter 14, Ms. Biswas in chapter 23, Ms. Pal in chapter 16, Ms. Bhattacharya in chapter 22 and Ms. Saha in chapter 10 need special mention. Among his scholars, the author wants to convey his special thanks to Mr. Patnaik, who helped him in many ways, which simply cannot be expressed in a few sentences.

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The architectural issues of knowledge based systems, which is the main theme of chapter 22, is the summary of the M.E. thesis (1991-1992) of Mr. Shirshendu Halder, who critically reviewed a large number of research papers and interestingly presented the pros and cons of these works in his thesis.

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Jadavpur University

Amit Konar

To my parents, Mr. Sailen Konar and Mrs. Minati Konar, who brought me up despite the stress and complexities of their lives and devoted themselves to my education;

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Amit Konar

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